CLAIMS

What is claimed is:

1. A hydrogen passivation shut down system for a fuel cell power plant (10), the system comprising:

a. at least one fuel cell (12) for generating electrical current from hydrogen containing reducing fluid fuel and oxygen containing oxidant reactant streams, the fuel cell (12) including an anode catalyst (14) and a cathode catalyst (16) on opposed sides of an electrolyte (18), an anode flow path (24) in fluid communication with the anode catalyst (14) for directing the hydrogen fuel to flow through the fuel cell (12) and adjacent the anode catalyst (14), and a cathode flow path (38) in fluid communication with the cathode catalyst (16) for directing the oxidant stream to flow through the fuel cell (12) and adjacent the cathode catalyst (14);

b. a hydrogen inlet valve (52) secured between a hydrogen containing reducing fluid fuel source (54) and the anode flow path (24) for selectively permitting the hydrogen fuel to flow into the anode flow path (24);

c. an oxidant inlet valve (56) secured between an oxygen containing oxidant source (58) and the cathode flow path (38) for selectively permitting the oxidant to flow into the cathode flow path (38);

d. hydrogen transfer means secured in communication between the anode flow path (24) and the oxidant flow path (38) for selectively permitting flow of the hydrogen fuel between the anode flow path (24) and the cathode flow

path (38); and,

e. hydrogen reservoir means secured in fluid communication with the anode flow path (24) for storing the hydrogen fuel whenever the hydrogen inlet valve (52) is open to permit flow of the hydrogen fuel through the anode flow path (24), and for releasing hydrogen fuel into the anode flow path (24) whenever the hydrogen inlet valve (52) is closed.

2. The system of claim 1, wherein the hydrogen reservoir means comprises a hydrogen vessel (66) secured outside the fuel cell (12) in fluid communication with the anode flow path (24).

3. The system of claim 2, wherein the hydrogen vessel (66) includes a hydrogen storage media stored within the vessel (66).

4. The system of claim 1, wherein the hydrogen reservoir means comprises a hydrogen storage media secured in fluid communication with the anode flow path (24).

5. The system of claim 1, wherein the hydrogen reservoir means comprises a hydrogen storage media secured within the anode flow path (24).

6. The system of claim 1, wherein the hydrogen reservoir means comprises a hydrogen storage media secured within a porous anode substrate layer (20) supporting the anode catalyst (14).

7. The system of claim 1, wherein the hydrogen transfer means comprises a hydrogen transfer valve (64)

secured in fluid communication between the anode flow path (24) and the cathode flow path (38).

8. The system of claim 1, wherein the hydrogen transfer means comprises a hydrogen transfer electrochemical pump including a direct current source secured in electrical communication with the fuel cell (12) so that hydrogen is consumed at the anode catalyst (14) and evolved at the cathode catalyst (16).

9. The system of claim 1, wherein the hydrogen transfer means comprises a hydrogen transfer proton exchange membrane electrolyte (18) secured between the anode catalyst (14) and cathode catalyst (16) that permits diffusion of hydrogen across the proton exchange membrane electrolyte (18) so that a concentration of hydrogen within the cathode flow path (38) may be in substantial equilibrium with a concentration of hydrogen within the anode flow path (24).

10. The system of claim 1, further comprising a cathode bypass valve (72) secured in fluid communication with a cathode exhaust (44) of the cathode flow path (38), a cathode bypass line (74) secured in fluid communication between the cathode bypass valve (72) and a cathode inlet (40) of the cathode flow path (24), and one of a cathode bypass blower (76) secured to the cathode bypass line (74) or an oxidant blower (60) secured to the cathode inlet (40) for selectively directing and accelerating flow of a cathode exhaust stream from the cathode exhaust (44) through the cathode inlet (40) of the cathode flow path (24).

11. The system of claim 1, further comprising an anode exhaust vent (34) secured in fluid communication with the anode flow path (24) for directing an anode exhaust stream away from the fuel cell (12) out of the power plant (10), and a cathode exhaust vent (48) secured in fluid communication with the cathode flow path (38) for directing a cathode exhaust stream away from the fuel cell (12) and out of the power plant (10), wherein the anode exhaust vent (34) and cathode exhaust vent (48) are secured below the fuel cell (12) with respect to a directional force of gravity (53).

12. The system of claim 11, wherein the anode exhaust vent (34) is a vacuum release valve and the cathode exhaust vent (48) is a vacuum release valve to prevent a vacuum from forming inside the fuel cell (12).

13. The system of claim 1, further comprising an anode recycle line (75) secured in fluid communication between an anode exhaust (30) of the anode flow path (24) and an anode inlet (26) of the anode flow path (24), and an anode recycle blower (77) secured to the anode recycle line (75) for selectively directing and accelerating flow of an anode exhaust stream between the anode exhaust (30) and anode inlet (26).

14. The system of claim 1, further comprising a hydrogen sensor means secured in communication with the fuel cell (12) for detecting a concentration of hydrogen within the anode flow path (24) and the cathode flow path (38).

15. The system of claim 14, wherein the hydrogen sensor means comprises a sensor circuit (80) secured in electrical communication with the anode catalyst (14) and the cathode catalyst (16) the sensor circuit (80) including a power source (84), a voltage-measuring device (86), and a sensor circuit switch (88), the sensor circuit (80) being secured to the fuel cell (12) so that the power source (84) may selectively deliver a pre-determined sensing current to the fuel cell (12) for a pre-determined sensing duration for measuring a voltage difference between the anode catalyst (14) and cathode catalyst (16).

16. The system of claim 1 further comprising an auxiliary load (94) connected to an external circuit (82), wherein the auxiliary load (96) an oxygen concentration within the cathode flow path (38) to be reduced and fuel cell voltage to be lowered.

17. A method of shutting down a fuel cell power plant (10), the power plant comprising at least one fuel cell (12) for generating electrical current from hydrogen containing reducing fluid fuel and oxygen containing oxidant reactant streams, the fuel cell (12) including an anode catalyst (14) and a cathode catalyst (16) on opposed sides of an electrolyte (18), an anode flow path (24) in fluid communication with the anode catalyst (14) for directing the hydrogen fuel to flow through the fuel cell (12) and adjacent the anode catalyst (14), and a cathode flow path (38) in fluid communication with the cathode catalyst (16) for directing the oxidant stream to flow through the fuel cell (12) and adjacent the cathode catalyst (14), the method comprising the

steps of:

a. disconnecting a primary load (90) from the fuel cell (12);

b. terminating flow of the oxidant into the cathode flow path (24) from an oxidant source (58);

c. connecting an auxiliary load (94) to the fuel cell (12);

d. permitting transfer of the hydrogen fuel from the anode flow path (24) into the cathode flow path (38);

e. terminating flow of the hydrogen fuel into the anode flow path (24) from a hydrogen fuel source (54) whenever the anode flow path (24) and cathode flow path (38) are filled with a hydrogen concentration of greater than seventy percent hydrogen; and,

f. permitting release into the anode flow path (24) and into the cathode flow path (38) of hydrogen stored within a hydrogen reservoir means for storing hydrogen secured in fluid communication with the anode flow path (24).

18. The method of claim 17, wherein the step of permitting transfer of hydrogen fuel from the anode flow path (24) into the cathode flow path (38) includes directing the hydrogen fuel to pass through a hydrogen transfer valve (64) secured in fluid communication between the anode flow path (24) and the cathode flow path (38).

19. The method of claim 17, wherein the step of permitting transfer of hydrogen fuel from the anode

flow path (24) into the cathode flow path (38) includes electrochemically pumping the hydrogen from the anode flow path (24) into the cathode flow path (38) by passing a direct current to the fuel cell (12).

20. The method of claim 17, wherein the step of permitting transfer of hydrogen fuel from the anode flow path (24) into the cathode flow path (38) includes securing a proton exchange membrane electrolyte (18) between the anode catalyst (14) and the cathode catalyst (16) so that the hydrogen may diffuse through the proton exchange membrane electrolyte (18) from the anode flow path (24) into the cathode flow path (38).

21. The method of claim 17, comprising the further step of, after the permitting transfer of the hydrogen fuel step, and before the terminating flow of the hydrogen fuel step, accelerating flow of a cathode exhaust stream with one of an oxidant blower (60) or a cathode bypass blower (76) from a cathode exhaust (44) of the cathode flow path (38) through a cathode bypass line (74) to a cathode inlet (40) of the cathode flow path (38).

22. The method of claim 17 comprising the further step of, after the step of permitting release of hydrogen into the anode flow path (24) from the hydrogen reservoir step, periodically sensing an amount of hydrogen within the anode flow path (24) or the cathode flow path (38) with a hydrogen sensor means for detecting a concentration of hydrogen within the anode flow path (24) or the cathode flow path (38), then admitting hydrogen into the anode flow

path (24) to a concentration of greater than seventy percent hydrogen whenever the sensor means detects the concentration of hydrogen within the anode flow path (24) or the cathode flow path (38) is below a predetermined concentration.

23. The method of claim 22, wherein the admitting hydrogen into the anode flow path (24) further comprises admitting hydrogen into the anode flow path (24) to a concentration of greater than ninety percent hydrogen within the anode flow path (24).

24. The method of claim 17, comprising the further step of, after the step of permitting release of hydrogen into the anode flow path (24) from the hydrogen reservoir step, periodically sensing an amount of hydrogen within the anode flow path (24) or the cathode flow path (38) with a hydrogen sensor means for detecting a concentration of hydrogen within the anode flow path (24) or the cathode flow path (38), then admitting hydrogen into the anode flow path (24) in a concentration that is inversely proportional to the detected concentration of hydrogen within the anode flow path (24) or the cathode flow path (38).

25. The method of claim 17, comprising the further steps of, after the step of permitting release of hydrogen into the anode flow path (24) from the hydrogen reservoir step, sensing an amount of hydrogen within the anode flow path (24) or the cathode flow path (38) with a hydrogen sensor means for detecting a concentration of hydrogen within the anode flow path (24) or the cathode flow path (38), then whenever the detected hydrogen concentration is less than

0.0001 percent, performing a rapid hydrogen fuel purge step wherein hydrogen fuel is directed to traverse the anode flow field (28) of the fuel cell (12) between an anode inlet (26) and an anode exhaust (30) in less than 1.0 seconds, then starting up the fuel cell (12).

26. The method of claim 25, wherein the rapid hydrogen fuel purge step further comprises directing the hydrogen fuel to traverse the anode flow field (28) of the fuel cell (12) between the anode inlet (26) and the anode exhaust (30) in less than 0.2 seconds.

27. The method of claim 25, wherein the rapid hydrogen fuel purge step further comprises directing the hydrogen fuel to traverse the anode flow field (28) of the fuel cell (12) between the anode inlet (26) and the anode exhaust (30) in less than 0.05 seconds.